# Clinical outcome in lumbar decompression surgery for spinal canal stenosis in the aged population: a prospective swiss multicenter cohort study

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Abstract: STUDY DESIGN This is a prospective, multicenter cohort study including 8 medical centers in the metropolitan area of the Canton Zurich, Switzerland. OBJECTIVES To examine whether outcome and quality of life might improve after decompression surgery for degenerative lumbar spinal stenosis (DLSS) even in patients older than 80 years and to compare data with a younger patient population from our own patient collective. SUMMARY AND BACKGROUND DATA Lumbar decompression surgery without fusion has been shown to improve quality of life in lumbar spinal canal stenosis. In the population older than 80 years, treatment recommendations for DLSS show conflicting results. METHODS Eight centers in the metropolitan area of Zurich, Switzerland agreed on the classification of DLSS, surgical principles, and follow-up protocols. Patients were followed from baseline, at 6 months, and 12 months. Baseline characteristics were analyzed with 5 different questionnaires "Spinal Stenosis Measure, Feeling Thermometer, Numeric Rating Scale, 5D-3L, and Roland and Morris Disability Questionnaire." In addition, our study population was compared with a younger control group. Furthermore, we calculated the minimal clinically important differences. RESULTS Thirty-seven patients with an average age of 82.5 $\pm$ 2.5 years reached the 12-month follow-up. Spinal Stenosis Measure scores, the Feeling Thermometer, the Numeric Rating Scale, and the Roland and Morris Disability Questionnaire showed significant improvements at the 6-month and 12-month follow-ups ($P < 0.001$). One EQ-5D-3Lsubgroup "anxiety/depression" showed no significant improvement ($P = 0.109$) at 12-month follow-up. The minimal clinically important difference for the "Symptom Severity scale" in the Spinal Stenosis Measure was achieved with improvement of 70% in the older patient population. CONCLUSION Patients 80 years or older can expect a clinically meaningful improvement after lumbar decompression for symptomatic DLSS. Our patient population showed significant positive development in quality of life in the short- and long-term follow-ups. LEVEL OF EVIDENCE 3.

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OUTCOMES

# Clinical Outcome in Lumbar Decompression Surgery for Spinal Canal Stenosis in the Aged Population

*A Prospective Swiss Multicenter Cohort Study*

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**Study Design.** This is a prospective, multicenter cohort study including 8 medical centers in the metropolitan area of the Canton Zurich, Switzerland.

**Objectives.** To examine whether outcome and quality of life might improve after decompression surgery for degenerative lumbar spinal stenosis (DLSS) even in patients older than 80 years and to compare data with a younger patient population from our own patient collective.

**Summary and Background Data.** Lumbar decompression surgery without fusion has been shown to improve quality of life in lumbar spinal canal stenosis. In the population older than 80 years, treatment recommendations for DLSS show conflicting results.

**Methods.** Eight centers in the metropolitan area of Zurich, Switzerland agreed on the classification of DLSS, surgical principles, and follow-up protocols. Patients were followed from baseline, at 6 months, and 12 months. Baseline characteristics were analyzed with 5 different questionnaires "Spinal Stenosis Measure, Feeling Thermometer, Numeric Rating Scale, 5D-3L, and Roland and Morris Disability Questionnaire." In addition, our study population was compared with a younger control group. Furthermore, we calculated the minimal clinically important differences.

**Results.** Thirty-seven patients with an average age of 82.5 ± 2.5 years reached the 12-month follow-up. Spinal Stenosis Measure scores, the Feeling Thermometer, the Numeric Rating Scale, and the Roland and Morris Disability Questionnaire showed significant improvements at the 6-month and 12-month follow-ups ($P < 0.001$). One EQ-5D-3Lsubgroup "anxiety/depression" showed no significant improvement ($P = 0.109$) at 12-month follow-up. The minimal clinically important difference for the "Symptom Severity scale" in the Spinal Stenosis Measure was achieved with improvement of 70% in the older patient population.

**Conclusion.** Patients 80 years or older can expect a clinically meaningful improvement after lumbar decompression for symptomatic DLSS. Our patient population showed significant positive development in quality of life in the short- and long-term follow-ups.

**Key words:** clinical outcomes, decompression, degenerative, laminectomy, laminotomy, lumbar spine, lumbar spinal canal stenosis, elderly, satisfaction, outcome.

**Level of Evidence:** 3

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With aging of the population, spine surgeons are currently more and more confronted with a wide variety of degenerative changes of the lumbar spine. The surgical management in the elderly population with degenerative lumbar spinal stenosis (DLSS) is among key clinical challenges. There is still confusion about the overall management strategies for older patients with DLSS. Furthermore, the literature lacks evidence on diagnosis and treatment of this entity.[1,2] Surgical treatment in the elderly population for degenerative spinal disorders is frequently associated with perioperative and intraoperative complications, which tend to increase with age. The percentage of older people in the population is rising; in the United States the proportion aged 65 years or

older is predicted to rise from 12% in 2000 to 20% in 2030.[3] It is estimated from data in the United States that every year 90 of 100.000 persons older than 60 years need lumbar decompression due to DLSS.[4] In the metropolitan area of Zurich with around 1.3 million inhabitants, more than 300 lumbar decompressions are done every year.[5] DLSS is a common condition seen by spinal surgeons. Symptoms usually consist of back and leg pain with sensory and motor deficits in the lower legs that worsen by walking longer distances. Symptoms are classically relieved by lumbar flexion. Failure of conservative treatment is an indication for surgery. The goal of surgery is to decompress the spinal canal and dural sac from degenerative bony and ligamentous overgrowth. Main treatment goals in surgical decompression are improvement in pain, functional status, and quality of life. DLSS is the most common indication for spinal surgery in the mature patient population.[6,7] Decompression laminotomy without instrumentation is the most common management in patients with DLSS on the one hand; on the other hand surgical risks are increasing in elderly patients due to age-related physiological changes and comorbidities.[8] For this reason, this multicenter cohort study "lumbar stenosis outcome study; LumbSten"[5] was designed to provide guidance in clinical-practical decision making for patients older than 80 years experiencing symptomatic DLSS. Furthermore, our aim was to provide evidence about the potential benefits in elderly patients that were treated by surgical decompression without fusion.

## MATERIALS AND METHODS

### Patient Selection

Patients were recruited during consultations at the spine surgery units or departments of Rheumatology of all participating centers. Magnetic resonance imaging verified lumbar spinal canal stenosis. The study population consists of patients with a minimum age of 80 years or older and a history of neurogenic claudication. Our control group consists of patients younger than 80 years. Patients had no evidence of stenosis caused by tumor, fracture, infection, or significant deformity (>15° lumbar scoliosis). All patients had no prior surgery at the lumbar spine and did not respond to conservative treatment. Furthermore, patients had no clinical peripheral artery occlusive disease (confirmed by a vascular specialist in patients without palpable pulses in the lower limb).

### Surgical Procedure

Surgery consisted of a standard open posterior lumbar laminectomy or laminotomy at the affected level or levels without instrumentation. Decompression of the lateral recessus and foramina was performed when necessary to decompress the local nerve roots. The use of loops or the microscope was at the preference of the spinal surgeon but was not recorded as part of the LSOS (Lumbar Spinal Outcome Study) trial.

### Data Collection and Follow-up

Basic data sheets were interview-administered and recorded by a study co-ordinator. All other questionnaires were self-administered and done by the patients themselves. Primary and secondary outcome data were collected at baseline, at 6 weeks, and 6 months after the time of treatment onset by mail. Long-term outcome data were gathered after 1 year and then annually up to 3 years by mail.

### Questionnaires

The following 5 questionnaires were included:

- *Cumulative Illness Rating Scale (CIRS):* Comorbidity was measured using CIRS, first established by Linn *et al*[9] that rates the ' and severity of comorbid diseases in 14 organ systems. Score range was from 0 to 56 (best-worst).
- *Spinal Stenosis Measure (SSM):* The SSM, an instrument initially developed by Stucki *et al*[10] targeted at measuring the disease status of the lumbar spinal stenosis population. It is recommended by the North American Spine Society and used in different studies on lumbar spinal stenosis.[11–14] It consists of 3 different subscales; the Symptom Severity subscale, the Physical Function subscale, and the Satisfaction subscale. It can be divided into a pain domain (severity, frequency, and back pain) and a neuroischemic domain (leg pain, weakness, numbness, and balance disturbance). Score range is from 1 to 5 and 1 to 4 (best-worst).
- *"Feeling Thermometer" and Numeric Rating Scale (NRS):* General assessment of lumbar spinal stenosis symptoms such as lower extremity "pain and discomfort" were measured. Score range is from 0 to 100 and 0 to 10 (best-worst).
- *EQ-5D-3L:* The EQ-5D-3L is another assessment tool to measure health-related quality of life. It measures general nondisease specific health-related quality of life, including physical, mental, and social dimensions.[15] The health status measures 5 dimensions of health (mobility, "self-care," usual activities, pain/discomfort, and "anxiety"/depression). The second part of the questionnaire estimates patient's "actual health" status.
- *Roland and Morris Disability Questionnaire:* The Roland and Morris Disability Questionnaire is a back pain specific, self-rated physical disability questionnaire developed by Roland and Morris in 1983.[16] Disability is measured respective to the following categories: Physical Function activities and activities of daily living including eating and sleeping. Score range is from 0 to 24 (best-worst).

### Minimal Clinically Important Differences

Minimal clinically important differences (MCIDs) are patient derived scores that reflect changes in a clinical intervention that are meaningful for the patient. Our estimation is based on the work of Stucki *et al*,[10] his group was able to show that at the 6-month follow-up a MCID occurs when the "Symptom Severity scale" or the "Physical Function scale" improves by at least 0.5 points. Furthermore, Ostelo *et al*[17] stated that the

MCID for the Feeling Thermometer could be estimated as a reduction by 15 points. Ostelo *et al*[17] stated an MCID for the NRS by a reduction of 2 points. The MCID for the Roland Morris Questionnaire was calculated for a reduction by at least 5 points.

### Ethics

This cohort study was conducted in compliance with all international laws and regulations as well as any applicable guidelines. The study was approved by the independent Ethics Committee of the Canton Zurich (KEK-ZH-NR: 2010-0395/0).

### Statistical Analyses

All results were transferred to a purpose built database (Filemaker Pro 11, 2010; FileMaker Inc., Santa Clara, CA). Descriptive statistics are used to provide data as mean ± standard deviation and ranges where appropriate. Test for normality of data distribution was done before use of parametric tests such as the Student *t* test for intergroup comparisons (2 tailed, nonpaired) or intragroup time-dependent comparisons (2 tailed, paired). The level of significance was defined as $P < 0.05$.

## RESULTS

### Patients Older Than 80 Years

At baseline, a total of 59 patients met the inclusion criteria. In the follow-up period, 1 patient was operated twice in the age group older than 80 years, this patient was excluded. In our patient population older than 80 years 37 patients reached the 12-month follow-up. Seventeen of them were females. The average age at time of surgery was 82.2 ± 2.5 years. The oldest patient was 89 years of age. The average CIRS total score was 9.9 ± 4 at baseline (Table 1).

**TABLE 1. Patient Characteristics and Control Group**

| | Patient Population (>80 yr) | Control Group (<80 yr) |
|---|---|---|
| N | 37 | 56 |
| Age at time of surgery | 82.5 ± 2.6 | 75 ± 2.6 |
| Sex (female) | 17 | 22 |
| CIRS | 9.9 ± 4.1 | 9.7 ± 4.2 |
| Levels of decompression | 1.9 ± 0.8 | 2.1 ± 0.8 |
| 1 level | 11 (29%) | 10 (18%) |
| >1 level | 26 | 46 |
| Retired | 32 (86%) | 55 (98%) |

*CIRS indicates cumulative illness rating scale.*

### Outcome of Age Group Older Than 80 Years

#### *SSM Score*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 2 and Figure 1A. Between all subgroups, we found significant improvement ($P < 0.001$) at the 6- and 12-month follow-ups.

#### *Feeling Thermometer and NRS Score*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 2 and Figure 1B, C. Both questionnaires showed significant improvement ($P < 0.001$) at the 6- and 12-month follow-ups.

#### *EQ-5D-3L Score*

The first part of the EQ-5D-3L score with baseline, 6-month and 12-month follow-ups is summarized in Table 2 and Figure 1D, E. In the second part of the EQ-5D-3L the average score of the "actual health status" at baseline was 55.2 ± 25.7; 73.2 ± 22.6 at 6-month follow-up and 77.5 ± 22.3 at the 12-month follow-up. Between all subgroups, we found significant improvements ($P < 0.001$) at the 6-month follow-up (Table 2). There was 1 subgroup (anxiety/depression) that showed no significant improvement ($P = 0.109$) at 12-month follow-up. Otherwise, all subgroups showed significant improvements at the 12-month follow-up.

#### *Roland and Morris Disability Questionnaire*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 2 and Figure 1F. There was significant improvement ($P < 0.001$) at the 6-month and 12-month follow-ups.

### Patients Younger Than 80 Years

In comparison with our patient population older than 80 years, we compared our results with a younger patient population (patients between 70 and 79 yr of age) from our own study group. Four patients were operated twice in this age group, these patients were excluded. At baseline, a total of 84 patients met the inclusion criteria. In our younger patient population, 56 patients reached the 12-month follow-up. Twenty-two of them were females. The average age at time of surgery was 75 ± 2.6 years. The oldest patient was 79 years, the youngest patient was 70 years. The average CIRS total score was 9.7 ± 4.2 at baseline (Table 1).

### Outcome of Age Group Younger Than 80 Years

#### *SSM Score*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 3. Between all subgroups, we found significant improvement ($P < 0.001$) at the 6-month and 12-month follow-ups (Table 3).

#### *Feeling Thermometer and NRS Score*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 3. Both questionnaires showed significant

**TABLE 2. Baseline and Follow-up Scores at 6 and 12 mo of Follow-up of Patients Older Than 80 yr**

| Questionnaire | Baseline | 6-mo FU >80 yr | *P* | 12-mo FU >80 yr | *P* |
|---|---|---|---|---|---|
| SSM | | | | | |
| Symptom severity | 3.1 ± 0.5 | 2.1 ± 0.7 | <**0.001** | 2.1 ± 0.9 | <**0.001** |
| Physical function | 2.4 ± 0.7 | 1.5 ± 0.6 | <**0.001** | 1.6 ± 0.9 | <**0.001** |
| Pain subdomain | 3.7 ± 0.6 | 2.2 ± 1.2 | <**0.001** | 1.6 ± 0.7 | <**0.001** |
| Neuroischemic subdomain | 2.6 ± 0.6 | 1.9 ± 0.6 | <**0.001** | 1.9 ± 0.8 | <**0.001** |
| Satisfaction score | 2.8 ± 0.7 | 1.8 ± 0.7 | <**0.001** | 1.7 ± 0.8 | <**0.001** |
| Feeling Thermometer | 64.9 ± 22.4 | 31.2 ± 24 | <**0.001** | 29.7 ± 28.4 | <**0.001** |
| NRS | 6.6 ± 2.3 | 3.3 ± 2.7 | <**0.001** | 3.1 ± 2.9 | <**0.001** |
| EQ-5D-3L score | | | | | |
| Mobility | 1.8 ± 0.4 | 1.5 ± 0.5 | <**0.001** | 1.3 ± 0.5 | <**0.001** |
| Self-care | 1.2 ± 0.4 | 1.1 ± 0.2 | 0.003 | 1.1 ± 0.2 | 0.002 |
| Usual activity | 1.7 ± 0.6 | 1.3 ± 0.5 | 0.002 | 1.2 ± 0.4 | <**0.001** |
| Pain/discomfort | 2.5 ± 0.4 | 1.6 ± 0.5 | <**0.001** | 1.6 ± 0.6 | 0.109 |
| Anxiety/depression | 1.4 ± 0.6 | 1.1 ± 0.5 | <**0.001** | 1.2 ± 0.5 | <**0.001** |
| Actual health status | 55.2 ± 25.7 | 73.2 ± 22.6 | 0.009 | 77.5 ± 22.3 | <**0.001** |
| Roland and Morris Disability Questionnaire | 13.1 ± 5.7 | 8.6 ± 5.6 | <**0.001** | 7.4 ± 5.6 | <**0.001** |

*FU indicates follow-up; SSM, Spinal Stenosis Measure; NRS, Numeric Rating Scale.*

improvement ($P < 0.001$) at the 6-month and 12-month follow-ups (Table 3).

#### *EQ-5D-3L Score*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 3. There was no significant improvement in the self-care ($P = 0.199$) and actual health ($P = 0.168$, Table 3) at the 6-month follow-up. Otherwise all other subgroups showed significant improvement at the 6-month follow-up at the 6-month follow-up. At the 12-month follow-up, 2 subgroups showed no significant improvement (anxiety/depression, $P = 0.532$ and actual health, $P = 0.416$). Otherwise all other subgroups showed significant improvement ($P < 0.001$, Table 3).

#### *Roland and Morris Disability Questionnaire*

Baseline scores, 6-month and 12-month follow-ups are summarized in Table 3. There was significant improvement ($P < 0.001$) at the 6-month and 12-month follow-ups (Table 2).

### Comparison Between Age Groups Older Than 80 Years and Age Group Younger Than 80 Years

Both groups had a similar CIRS score at baseline of 9.9 ± 4.1, respectively 9.7 ± 4.2 ($P = 0.87$). At baseline, there were no statistical significant differences between the 2 groups in any of our questionnaires. During the first follow-up at 6 months, there was 1 subgroup in the EQ-5D-3L (pain/discomfort) significantly different ($P < 0.001$). At the 12-month follow-up, 2 questionnaires/subgroups showed significant differences. The EQ-5D-3L (pain/discomfort), ($P = 0.012$) and EQ-5D-3L (actual health), ($P = 0.003$, Table 4).

### MCIDs in the Age Group Older Than 80 Years

In the 12-month follow-up, 70.6% of our patients experienced a clinical meaningful improvement in the Symptom Severity scale. In the Physical Function scale, 64.7% experienced a clinical meaningful improvement at the 12-month follow-up. All MCIDs of both age groups are summarized in Table 5.

### Complications

In the patient group older than 80 years, we had 1 reoperation due to epidural bleeding. We also experienced 4 intraoperative dural perforations that were not clinical significant and no revision was required. There were no reported wound infections. In the patient group younger than 80 years, we experienced 3 reoperations due to bleeding, infection, or dural tear.

## DISCUSSION

This study investigates 57 consecutive cases, of which 37 made it to the 1-year mark, of conventional open lumbar decompression surgery in patients older than 80 years. To our knowledge, this is the first multicenter cohort study that

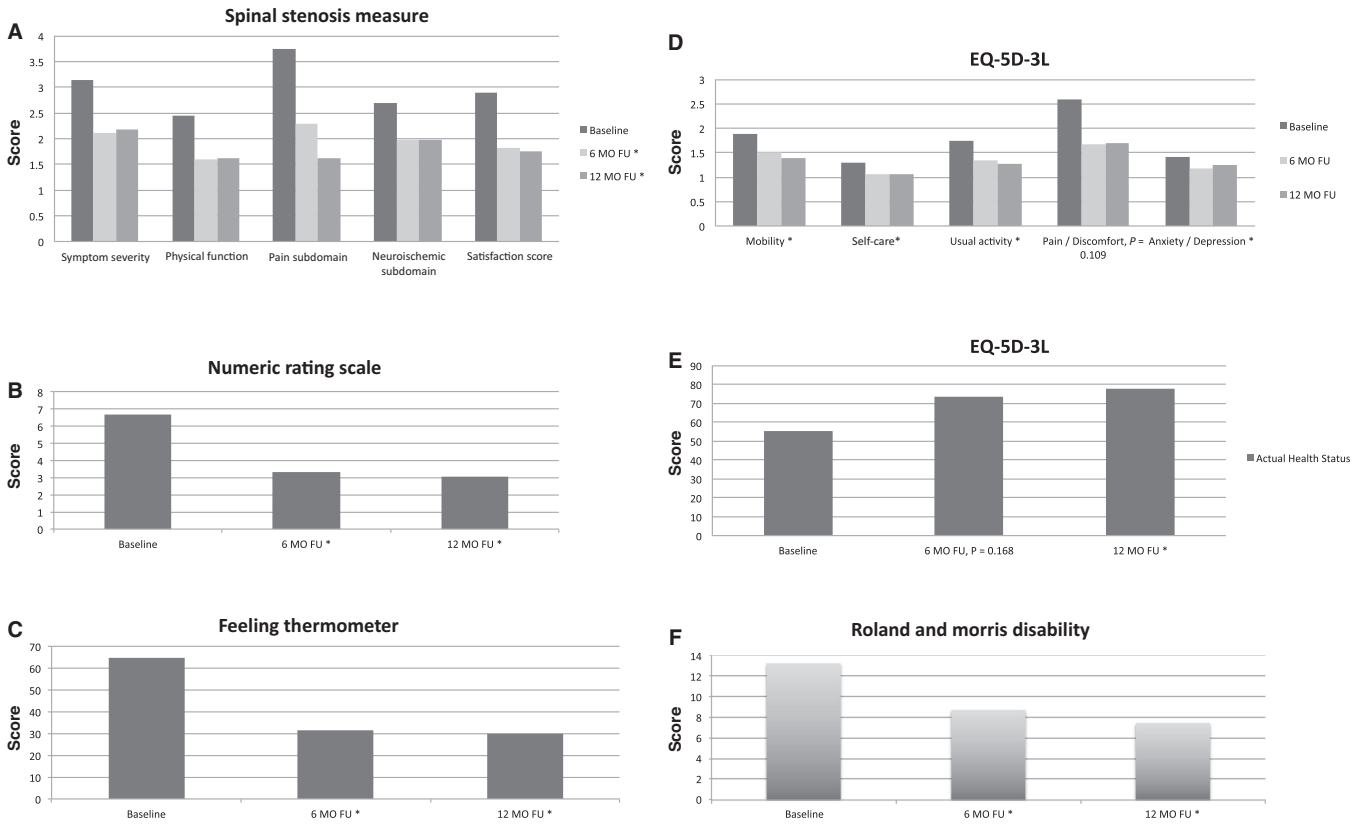


**Figure 1. A–F**, Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years. *Statistical significance. **A**. Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years for Spinal Stenosis Measure. *Statistical significance. **B**, Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years for numeric rating scale. *Statistical significance. **C**, Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years for Feeling Thermometer. *Statistical significance. **D**, Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years for the EQ-5D-3L. *Statistical significance. **E**, Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years for the EQ-5D-3L (actual health status). *Statistical significance. **F**, Score summary at baseline, 6 months of follow-up, and 12 months of follow-up in the age group older than 80 years for the Roland and Morris Disability Questionnaire. *Statistical significance.

evaluated outcome in patients in their early 80s for DLSS. In addition, our results were compared with a younger control group that has been enrolled in the same study population. Our study confirms that simple decompression without fusion is a helpful treatment in patients with DLSS even at the age of 80 and older. Our results demonstrate favorable outcome and satisfaction in our patient population. Furthermore, our results showed improved and stable outcome in the 6-month and 12-month follow-ups. In comparison with our younger control group, our results point to similar potential for clinical improvement after simple decompression without fusion. We further showed clinical meaningful improvement in the SSM (Symptom Severity) in the long-term follow-up by 70% in our older patient population.

Other studies showed similar results.[18–21] Katz *et al*[22] reported a satisfaction rate of 75% with a mean age of 69 years. Furthermore, Sanderson and Wood[23] reported excellent outcome in 64% of patients with a mean age of 65 years. In comparison, our study included patients with a mean age of 82.5 years of age. In 2 other studies with similar mean ages Galiano *et al*[24] and Shabat *et al*[25] reported a satisfaction rate of 65% and 76%. Both studies lacked a direct younger control group. Several studies stated that comorbidity is associated with worse outcome.[8,26] Our patient population and the younger control group had a similar comorbidity score (CIRS) reflecting the normative comorbidity values of both age groups.[27] Certainly, none of our patients died within the 12-month follow-up period reflecting the average life expectancy in Switzerland. In our population, there does not seem to be an additional age-effect with respect to outcome and in comparison with our younger patient group. Our short- and long-term outcomes are comparable with that of other trials including elderly patients. However, different study designs in other studies make direct comparison difficult.[18,25,28]

The majority of our patients showed in the follow-up period of 6 and 12 months clinically significant improvement calculated by the MCID. Our calculation is based on the work of Stucki *et al*,[10] his group was able to show that at the 6-month follow-up a MCID occurs when the Symptom Severity scale and Physical Function scale improves by at least 0.5 points. In our study, the calculated MCID in our older patient population at the 12-month follow-up for the

**TABLE 3. Baseline and Follow-up Scores at 6 and 12 mo of Follow-up of Patients Younger Than 80 yr**

| Questionnaire | Baseline | 6-mo FU <80 yr | *P* | 12-mo FU <80 yr | *P* |
|---|---|---|---|---|---|
| SSM | | | | | |
| Symptom severity | 3.1 ± 0.6 | 2.3 ± 0.8 | <**0.001** | 2.2 ± 0.7 | <**0.001** |
| Physical function | 2.2 ± 0.7 | 1.6 ± 0.6 | <**0.001** | 1.5 ± 0.6 | <**0.001** |
| Pain subdomain | 3.8 ± 0.7 | 2.5 ± 0.9 | <**0.001** | 2.4 ± 0.9 | <**0.001** |
| Neuroischemic subdomain | 2.6 ± 0.8 | 2.1 ± 0.8 | <**0.001** | 2.1 ± 0.7 | <**0.001** |
| Satisfaction score | 2.7 ± 0.7 | 1.7 ± 0.7 | <**0.001** | 1.8 ± 0.8 | <**0.001** |
| Feeling Thermometer | 66.3 ± 21.6 | 35.1 ± 25.6 | <**0.001** | 35.8 ± 23.39 | <**0.001** |
| NRS | 6.3 ± 2.3 | 3.4 ± 2.5 | <**0.001** | 3.5 ± 2.3 | <**0.001** |
| EQ-5D-3L score | | | | | |
| Mobility | 1.8 ± 0.4 | 1.5 ± 0.6 | 0.002 | 1.4 ± 0.5 | <**0.001** |
| Self-care | 1.2 ± 0.4 | 1.1 ± 0.4 | 0.199 | 1.1 ± 0.2 | 0.011 |
| Usual activity | 1.6 ± 0.5 | 1.4 ± 0.6 | 0.004 | 1.3 ± 0.5 | <**0.001** |
| Pain/discomfort | 2.3 ± 0.5 | 1.9 ± 0.5 | <**0.001** | 1.8 ± 0.5 | <**0.001** |
| Anxiety/depression | 1.2 ± 0.4 | 1.1 ± 0.4 | 0.033 | 1.2 ± 0.5 | 0.532 |
| Actual health status | 61.2 ± 22.2 | 68.4 ± 24.7 | 0.168 | 65.5 ± 22.4 | 0.416 |
| Roland and Morris Disability Questionnaire | 12.8 ± 5.3 | 8.1 ± 5.7 | <**0.001** | 7.8 ± 5.5 | <**0.001** |

*SSM indicates Spinal Stenosis Measure; NRS, Numeric Rating Scale; FU, follow-up.*

**TABLE 4. Comparison Between Patient Population and Control Group in the 6-mo Follow-up and 12-mo Follow-up**

| Questionnaire | *P* = 80 yr *vs.* <79 yr at 6-mo FU | *P* = 80 yr *vs.* <79 yr at 12-mo FU |
|---|---|---|
| SSM | | |
| Symptom severity | NSD | NSD |
| Physical function | NSD | NSD |
| Pain subdomain | NSD | NSD |
| Neuroischemic subdomain | NSD | NSD |
| Satisfaction score | NSD | NSD |
| Feeling Thermometer | NSD | NSD |
| NRS | NSD | NSD |
| EQ-5D-3L | | |
| Mobility | NSD | NSD |
| Self-care | NSD | NSD |
| Usual activity | NSD | NSD |
| Pain/discomfort | **0.002** | **0.013** |
| Anxiety/depression | NSD | NSD |
| Actual health status | NSD | **0.003** |
| Roland and Morris Disability Questionnaire | NSD | NSD |

*Mo indicates month; FU, follow-up; NSD, nonstatistical difference; SSM, Spinal Stenosis Measure.*

**TABLE 5. MCID in Age Groups Older Than 80 yr and Younger Than 80 yr at 12 mo of Follow-up %***

| Age Group | Symptom Severity | Physical Function | Feeling Thermometer | NRS | Roland and Morris Disability Questionnaire |
|---|---|---|---|---|---|
| 12-mo FU; >80 yr | 70.6% | 64.7% | 70.6% | 75% | 50% |
| 12-mo FU; <80 yr | 70.6% | 50.9% | 68.6% | 62% | 49% |

*Percentage of patients that reflected a relevant clinically meaningful improvement.

MCID indicates minimal clinically important difference; FU, follow-up.

Symptom Severity scale and the Physical Function scale was more than 70% and 64% from baseline, respectively. Ostelo *et al*[17] stated that the MCID for the Feeling Thermometer could be estimated as a reduction by 15 points. Seventy percent of our patients showed a clinical meaningful improvement in the Feeling Thermometer at the 12 months follow-up in comparison with baseline reflecting obvious progress in our patients (Table 5).

Whether type of surgery is a predictor for outcome remains controversial and was not part of our study. We used a standard open posterior lumbar laminectomy or laminotomy at the affected level or levels without fusion. The decompression of the lateral recessus and foramina was performed when necessary. In the meantime new minimally invasive techniques (MIS) for decompression have been introduced in the clinical practice with good clinical results.[29,30] Ang *et al*[31] compared the open approach with MIS lumbar laminotomy and concluded no clear advantages in the MIS group in terms of outcome in the 2 years of follow-up. Those MIS techniques may reduce tissue disruption, reduce blood loss, and show wound pain reduction in the postoperative phase. Further long-term follow-up studies need to be conducted to evaluate these early results.

A limitation of our study is the relatively small number of operated patients. Only 37 of the 59 initially enrolled subjects reached the 12-month follow-up. It is possible that those who did not follow-up tended to be in a more/or less satisfied group. A follow-up period of 2 years would strengthen our study to evaluate the continued effect of improvement. In addition, patients with higher risk factors (*e.g.*, higher CIRS than in our cohort) might not benefit from decompression or may not been recommended for surgery at all.

As part of the lumbar spinal outcome study (lumbSten; www.lumbalstenose.ch),[5] we will present our 2- and 3-year results in the future. Other publications mentioned in the previous text showed drawbacks in study design and analysis with lack of a control group and performance of previous back surgical procedures, which might draw false assumptions.

The number of persons older than 80 years with DLSS is rising. The purpose of surgery for symptomatic lumbar spinal stenosis is to decompress degenerative bony and ligamentous overgrowth. Our study seems to give evidence that even older patients are suitable for surgical treatment.

## CONCLUSION

Patients 80 years or older can expect a clinically meaningful improvement after lumbar decompression for symptomatic DLSS. Our patient population confirms significant positive development in quality of life in the short- and long-term follow-ups. Simple open decompression without fusion in advanced ages in patients with DLSS verifies comparable outcome in patient's satisfaction in comparison with our younger control group.

### ➢ Key Points

- ❑ Surgical management in the elderly population with DLSS is among key clinical challenges.
- ❑ SSM scores, the Feeling Thermometer, and the NRS showed significant improvements at the 6- and 12-month follow-up ($P < 0.001$).
- ❑ In the 12-month follow-up around 70% of our patients experienced a clinical meaningful improvement in the Symptom Severity scale.
- ❑ Patients 80 years or older can expect a clinically meaningful improvement after lumbar decompression for symptomatic DLSS.
- ❑ Our patient population confirms positive development in quality of life in the 6-month and 12-month follow-ups.

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### References

1. Watters WC III, Baisden J, Gilbert TJ, et al. Degenerative lumbar spinal stenosis: an evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spinal stenosis. *Spine J* 2008;8:305–10.

2. Allen RT, Rihn JA, Glassman SD, et al. An evidence-based approach to spine surgery. *Am J Med Qual* 2009;24:15S–24S.
3. Social Security Administration. *Annual Report on the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds (2001) Social Security Administration, Baltimore*. 2001.
4. Deyo RA, Gray DT, Kreuter W, et al. United States trends in lumbar fusion surgery for degenerative conditions. *Spine (Phila Pa 1976)* 2005;30:1441–5; discussion 6–7.
5. Steurer J, Nydegger A, Held U, et al. LumbSten: the lumbar spinal stenosis outcome study. *BMC Musculoskeletal Disord* 2010;11:254.
6. Ciol MA, Deyo RA, Howell E, et al. An assessment of surgery for spinal stenosis: time trends, geographic variations, complications, and reoperations. *J Am Geriatr Soc* 1996;44:285–90.
7. Gunzburg R, Szpalski M. The conservative surgical treatment of lumbar spinal stenosis in the elderly. *Eur Spine J* 2003;12 (suppl 2):S176–80.
8. Airaksinen O, Herno A, Turunen V, et al. Surgical outcome of 438 patients treated surgically for lumbar spinal stenosis. *Spine (Phila Pa 1976)* 1997;22:2278–82.
9. Linn BS, Linn MW, Gurel L. Cumulative illness rating scale. *J Am Geriatr Soc* 1968;16:622–6.
10. Stucki G, Liang MH, Fossel AH, et al. Relative responsiveness of condition-specific and generic health status measures in degenerative lumbar spinal stenosis. *J Clin Epidemiol* 1995;48: 1369–78.
11. Tuli SK, Yerby SA, Katz JN. Methodological approaches to developing criteria for improvement in lumbar spinal stenosis surgery. *Spine (Phila Pa 1976)* 2006;31:1276–80.
12. Zucherman JF, Hsu KY, Hartjen CA, et al. A multicenter, prospective, randomized trial evaluating the X-STOP interspinous process decompression system for the treatment of neurogenic intermittent claudication: two-year follow-up results. *Spine (Phila Pa 1976)* 2005;30:1351–8.
13. Hansraj KK, O'Leary PF, Cammisa FP, Jr, et al. Decompression, fusion, and instrumentation surgery for complex lumbar spinal stenosis. *Clin Orthop Relat Res* 2001;384:18–25.
14. Fokter SK, Yerby SA. Patient-based outcomes for the operative treatment of degenerative lumbar spinal stenosis. *Eur Spine J* 2006;15:1661–9.
15. Hinz A, Klaiberg A, Brahler E, et al. The Quality of Life Questionnaire EQ-5D: modeling and norm values for the general population. *Psychother Psychosom Med Psychol* 2006;56:42–8.
16. Roland M, Morris R. A study of the natural history of low-back pain. Part II: development of guidelines for trials of treatment in primary care. *Spine (Phila Pa 1976)* 1983;8:145–50.
17. Ostelo RW, Deyo RA, Stratford P, et al. Interpreting change scores for pain and functional status in low back pain: toward international consensus regarding minimal important change. *Spine (Phila Pa 1976)* 2008;33:90–4.
18. Ragab AA, Fye MA, Bohlman HH. Surgery of the lumbar spine for spinal stenosis in 118 patients 70 years of age or older. *Spine (Phila Pa 1976)* 2003;28:348–53.
19. Scholz M, Firsching R, Lanksch WR. Long-term follow up in lumbar spinal stenosis. *Spinal Cord* 1998;36:200–4.
20. Vitaz TW, Raque GH, Shields CB, et al. Surgical treatment of lumbar spinal stenosis in patients older than 75 years of age. *J Neurosurg* 1999;91:181–5.
21. Jakola AS, Sorlie A, Gulati S, et al. Clinical outcomes and safety assessment in elderly patients undergoing decompressive laminectomy for lumbar spinal stenosis: a prospective study. *BMC Surg* 2010;10:34.
22. Katz JN, Stucki G, Lipson SJ, et al. Predictors of surgical outcome in degenerative lumbar spinal stenosis. *Spine (Phila Pa 1976)* 1999;24:2229–33.
23. Sanderson PL, Wood PL. Surgery for lumbar spinal stenosis in old people. *J Bone Joint Surg Br* 1993;75:393–7.
24. Galiano K, Obwegeser AA, Gabl MV, et al. Long-term outcome of laminectomy for spinal stenosis in octogenarians. *Spine (Phila Pa 1976)* 2005;30:332–5.
25. Shabat S, Arinzon Z, Folman Y, et al. Long-term outcome of decompressive surgery for lumbar spinal stenosis in octogenarians. *Eur Spine J* 2008;17:193–8.
26. Katz JN, Lipson SJ, Brick GW, et al. Clinical correlates of patient satisfaction after laminectomy for degenerative lumbar spinal stenosis. *Spine (Phila Pa 1976)* 1995;20:1155–60.
27. Miller MD, Paradis CF, Houck PR, et al. Rating chronic medical illness burden in geropsychiatric practice and research: application of the cumulative illness rating scale. *Psychiatry Res* 1992;41:237–48.
28. Fredman B, Arinzon Z, Zohar E, et al. Observations on the safety and efficacy of surgical decompression for lumbar spinal stenosis in geriatric patients. *Eur Spine J* 2002;11:571–4.
29. Polikandriotis JA, Hudak EM, Perry MW. Minimally invasive surgery through endoscopic laminotomy and foraminotomy for the treatment of lumbar spinal stenosis. *J Orthop* 2013;10:13–6.
30. Mobbs RJ, Li J, Sivabalan P, et al. Outcomes after decompressive laminectomy for lumbar spinal stenosis: comparison between minimally invasive unilateral laminectomy for bilateral decompression and open laminectomy. *J Neurosurg Spine* 2014;21:1–8.
31. Ang CL, Phak-Boon Tow B, Fook S, et al. Minimally invasive compared with open lumbar laminotomy: no functional benefits at 6 or 24 months after surgery. *Spine J* 2013;S1529–9430:01382–X.